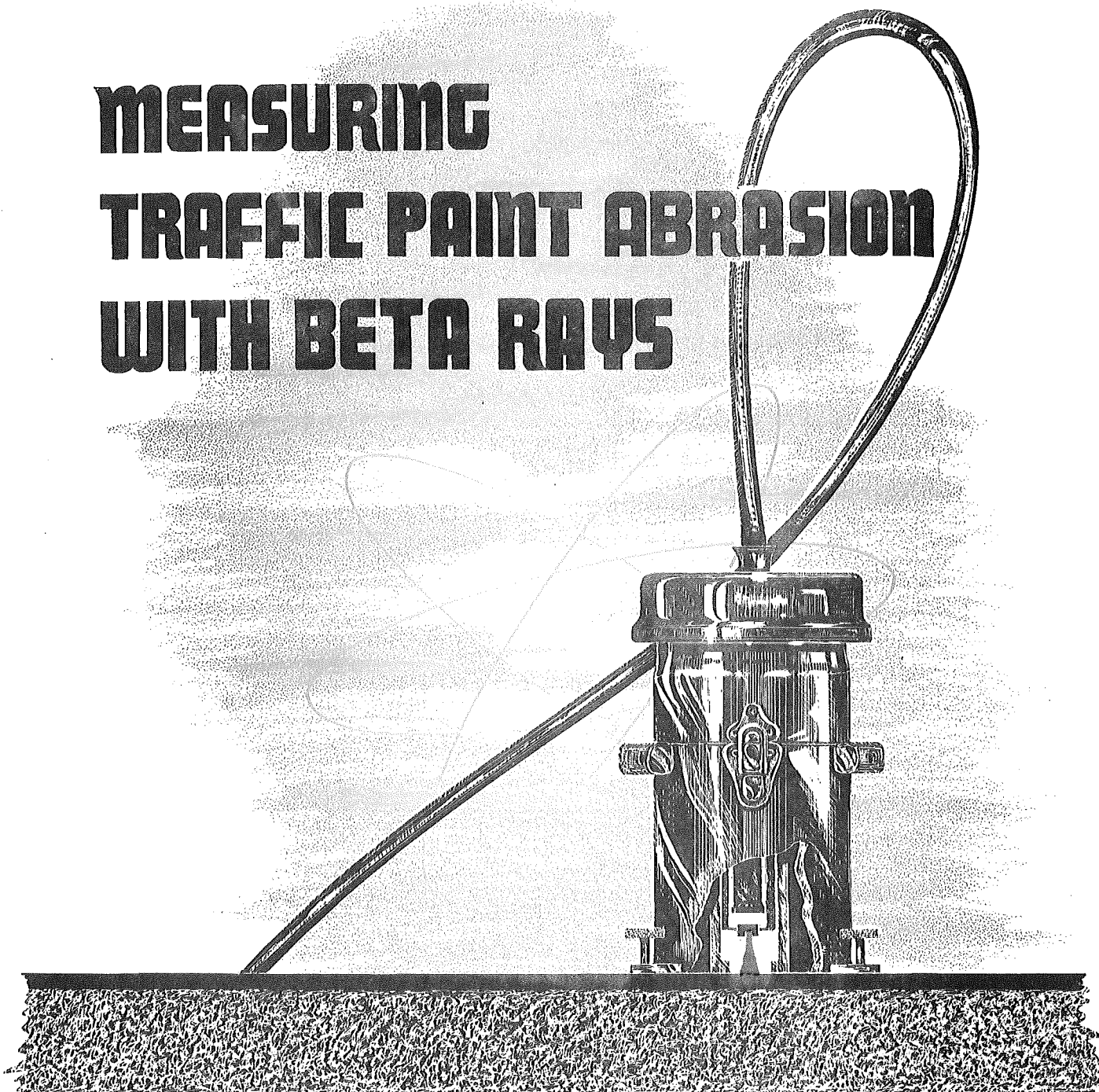


# MEASURING TRAFFIC PAINT ABRASION WITH BETA RAYS



DECEMBER 1954

MICHIGAN  
STATE HIGHWAY DEPARTMENT

CHARLES M. ZIEGLER  
STATE HIGHWAY COMMISSIONER

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MEASURING TRAFFIC PAINT ABRASION  
WITH BETA RAYS

by

B. W. Pocock

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### SYNOPSIS

The author traces the early history of experiments conducted by the Michigan State Highway Department for the purpose of developing a laboratory wear test for traffic paint. A major difficulty was found to be that of appraising paint wear. A new method of evaluating paint wear was developed by the department's research laboratory. The method utilizes radioactivity in the form of a beta ray backscatter gage charged with only 10 microcuries of strontium 90. Design of the gage is presented, along with backscatter counting rates at infinite thickness of several common engineering materials. A table of percentages is given by means of which it is possible to construct calibration curves of counting rates vs. thicknesses in mils of unknown coatings. Application of the Michigan gage to paint wear tests is illustrated by curves of thickness in mils of traffic paint stripes vs. revolutions of a paint wear machine.

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## INTRODUCTION

The modern traffic paint is a development of the protective coating industry. Although that industry reflects one of the oldest manufacturing technologies in the world, unfortunately the formulation and production know-how which the craft has acquired from experience throughout the ages in the field of protective and decorative engineering does not uniquely insure per se the immediate development of an excellent pavement marking paint.

A traffic paint is not intended to afford protection against corrosion, warping, rotting, or the absorption of water. It is not fundamentally decorative. Its primary function is to impart a signal. In order that it may impart any signal whatever it must be there, where it is needed, at the time when it is needed. This is at all times.

A traffic paint therefore must possess unusual durability characteristics. Not only must it adhere tenaciously to the underlying pavement surface; it must also resist vigorously all factors operating to reduce the thickness of the dried paint film. Such factors, in addition to the well-known elements of weather, include chemical attack by salts used for snow and ice removal, solvent action by oils and gasoline, and direct physical abrasion by road-scraping machinery, by dust, and by the movement of normal traffic.

In addition, pavement paints must resist the expansion and contraction differentials attending repetitive freezing and thawing cycles. They must be able to accept and to hold glass beads. Daily and seasonal temperature fluctuations must be without significant effect, as must be true also of the bleaching action of ultraviolet light on the vehicle employed. The paint must resist leaching by rain water and bleeding through of bituminous materials in and on the highway. It must be capable of being sprayed. Viscosity demands are rather exact.

The above requirements place highway paints in a category far different from those of other paints. It is little wonder that the ideal traffic paint is yet to be produced. It is no wonder at all that a satisfactory laboratory test has never been devised for predicting the durability of traffic paint under field conditions.

#### Paint Wear Machine Developed by the Michigan State Highway Department

##### Research Laboratory

For several years the Michigan State Highway Department's testing and research division has been concerned with the growing need for a method of correlating laboratory behavior with field performance of traffic paints. Early efforts by the department's research laboratory to fill this need centered around the use of a paint wear machine, designed for studies of abrasion resistance. In this machine, which is shown in Figures 1 and 2, a flat ring of dense portland cement mortar is supported in such a manner that it is free to rotate on a turntable. The ring is made of six similar segments clamped together in the form of an annulus.

Paint stripes are applied by doctor blade on the mortar ring. After a suitable drying and curing period a vertical drive wheel is set in motion, which rests on top of the ring on one side of the machine, makes the ring rotate about 33 rpm, and therefore passes over all paint stripes.

Simultaneously, a similar vertical wheel on the other side of the machine rests on the ring, and all paint stripes pass beneath it. This second wheel is braked by a 10-lb weight acting on a prony brake. Originally both drive wheel and brake wheel were capped by flat eraser stock abrasive tires furnished by a well-known pencil manufacturer.

Since the paint stripes were 2 inches wide and the wheels under which they passed were also 2 inches in width, any abrasion resulted in a square 2 inches on each side being worn into the paint film to an unknown depth, as shown in Figure 3. A 2-inch square grid was etched on a glass plate with lines  $1/4$  inch apart, thus establishing 64 small squares. After a given number of revolutions of the mortar ring, this grid was placed over the square of wear in each paint stripe and the number of small squares was counted which showed complete wear through to the mortar base. The number of small squares for each paint showing complete wear was plotted against the number of revolutions of the mortar ring, and in this way curves of abrasion resistance were obtained which it was hoped might correlate with performance as observed in the field.

Some correlation with field behavior was observed in these early tests. The results, however, were inconsistent, and it was recognized that the test would have to be greatly improved before it would be of value. Accordingly, provision was made for wet cycles as well as for dry cycles, a water spray being turned on during the wet cycles. Drive and brake wheels were counterbalanced to the extent that pressure over tire contact areas corresponded with that in the case of conventional passenger cars. Paints were applied by doctor blade with the same setting for all paints. It was realized that this would not necessarily insure that all paint films would have the same dry film thickness as a result, but it was felt that it might be a "step in the right direction". The same mortar ring was cleaned and

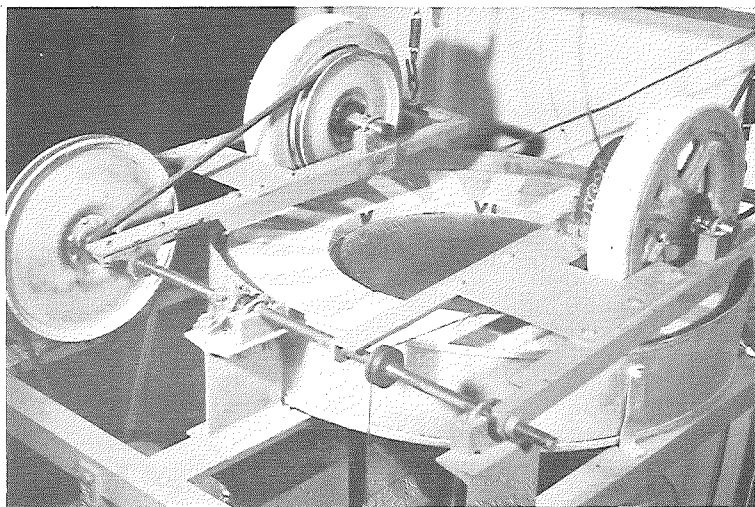


FIGURE 1. PAINT WEAR MACHINE. OBLIQUE VIEW.

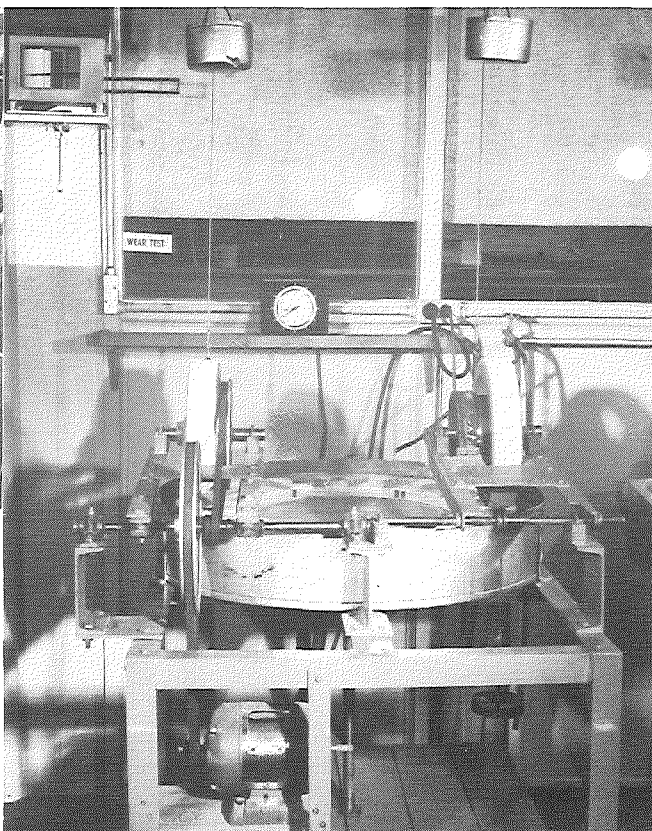


FIGURE 2. PAINT WEAR MACHINE, FRONT VIEW.

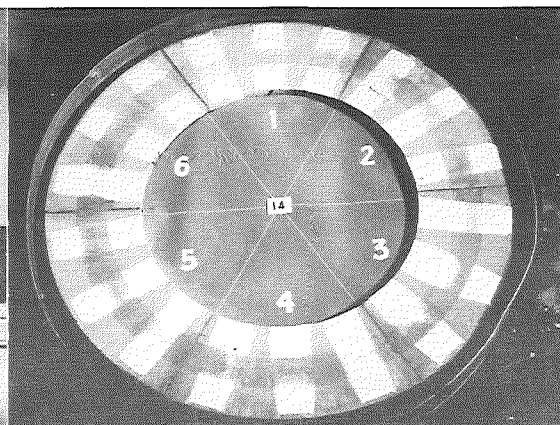


FIGURE 3. WHEEL TRACK AREAS PASSING THROUGH PAINT STRIPES ON MORTAR RING OF PAINT WEAR MACHINE.

FIGURE 4. BETA GAGE COMPLETELY ASSEMBLED.

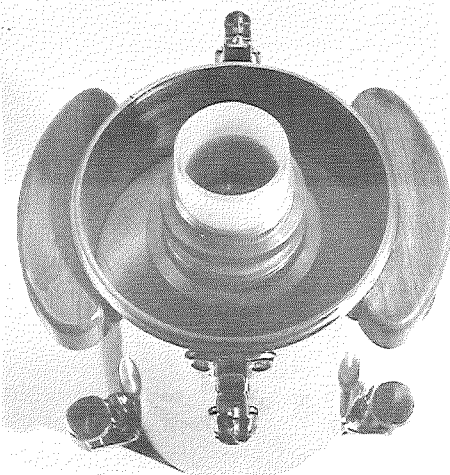


FIGURE 5. BETA GAGE SHOWING VIEW WITH EXTERIOR COVER REMOVED.

FIGURE 6. BETA GAGE SHOWING VIEW WITH COUNTER TUB, PLASTIC CYLINDERS AND SOURCE HOLDER REMOVED.

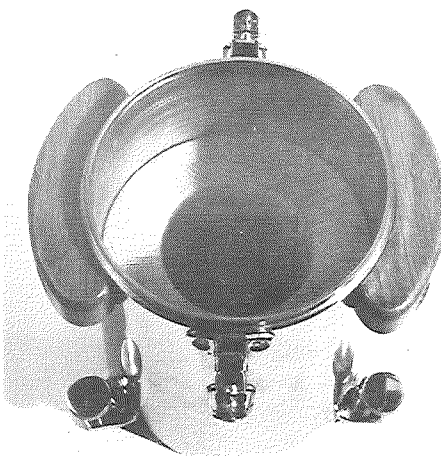
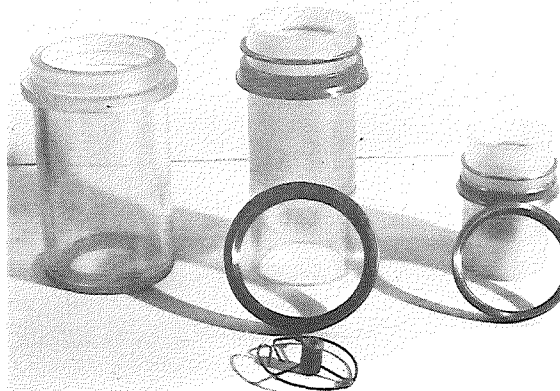


FIGURE 7. BETA GAGE SHOWING SOURCE HOLDER, PLASTIC CYLINDERS AND BRASS FRICTION RINGS COMPRISING INTERIOR - ASSEMBLED.

FIGURE 8. SAME AS ABOVE - UNASSEMBLED.





used over and over again. Different paint curing methods were studied, including the use of oven heat and infrared radiation. The eraser stock tires were replaced by abrasive-impregnated tires furnished by an automotive brake lining manufacturer. The prony brake was removed from the drag wheel, allowing the latter to run freely. Nothing resulted in an acceptable degree of conformity with field performance, however. It was believed that the method of application of the paint and the method of appraisal might both be at fault.

#### APPRAISAL BY RADIOACTIVITY

The isotope section of the research laboratory took up the task of developing a method for measuring the thicknesses of dry paint coatings under the assumption that any such method, if sufficiently accurate, should increase the precision of evaluating results of wear tests. Moreover, such a technique, if successful, would make it possible to follow actual changes in thickness of paint stripes during tests without the necessity of waiting until the supporting base began to show through. Because of the non-magnetic nature of concrete and the various types of blacktop pavements, plus the desirability of developing a method which could be used in the field as well as in the laboratory, it was felt that a procedure based upon radioactivity would have to be employed.

Three such procedures presented themselves for consideration. The principle of tracer technology would involve incorporating radioactivity into the paint (tagging) and measuring decrease in activity as the paint wore away. It would also introduce a health hazard from the standpoint of radioactive waste and dust disposal, and was therefore ruled out at the start. A second method would make use of activity applied on the pavement surface, measurements being taken of the increase in activity as the overlying



paint wore away. Here again, considerations of safety rendered the method undesirable. The principle of beta ray backscatter, however, utilizes a sealed source of radioactivity and determines the thicknesses of materials by measuring the rates at which the materials bounce beta particles back into the counter tube. It was decided therefore to adopt the backscatter method in this investigation.

As reported by Zumwalt (1) and by Clarke, Carlin and Barbour (2), materials react in three ways on being bombarded by beta rays. If the materials are sufficiently thin, they will transmit a portion of the radiation. No matter what the thickness, they will always absorb a portion. Lastly, they reflect a portion, and it is this reflected portion which is made use of in the beta ray backscatter gage.

#### Michigan's Beta Gage:

The design of the Michigan State Highway Department's beta ray backscatter gage is shown in Figures 4 through 8. The strontium 90 source of approximately 10 microcuries (half-life, 25 years; cost, one cent) is sealed in a brass holder in such a way that its beta radiation can escape only in a generally downward direction. Immediately above the source holder is the open window of a TGC 2 end-window counter tube. Ideally no radiation can enter the tube because of the mass of the brass holder, which acts as a shield. Actually, a "background" averaging 1.64 counts per second is observed when the assembled gage is suspended in open air several feet above the floor. This background includes normal atmospheric radiation originating in thoron and radon disintegration, cosmic radiation, and beta rays from the Sr 90 source which escape the shielding and/or are reflected by the plastic tubing. These latter may produce X-rays (bremsstrahlung), which contribute to the background.

When the gage is placed on the surface of a given material, however, the counting rate rises considerably. Depending upon the nature of the material, the rate may be 20, 30 or 40 counts per second, or much higher. It reaches 169.50 c/s when placed on lead, which possesses outstanding ability to reflect beta rays. Yet before one can state categorically that 169.50 c/s is characteristic of lead with a particular geometry, source energy, source strength and counter assembly, one must be certain that the lead is of at least "infinite" thickness. By infinite thickness is meant that thickness which is infinite for beta ray backscatter counting. With materials of less than infinite thickness, the beta ray backscatter counting rate is a function of the thickness; beyond infinite thickness the rate becomes constant for any thickness. Friedlander and Kennedy (3) report that the infinite thickness of any material for beta ray backscatter is about one-fifth of the total range of the beta particles in that material. The range in turn depends upon the energy of the beta particles and upon the properties of the material.

In general, the rate at which a material will reflect or backscatter beta rays is a function of the material's atomic number,  $Z$ . More precisely, Zumwalt (4) reports that the rate varies directly as  $Z^{0.7}$  to  $Z^{0.8}$ . Since most engineering materials are mixtures of chemical compounds, one may logically employ the term "effective atomic number" as a sort of average for all of the atoms in a given material. Figures 9 through 11 show the counting rates for infinite thicknesses of various materials as determined using the Michigan gage. These are net rates (background subtracted). The rates shown for the elements Al, Cu, Ag and Pb were used to establish the curve. Points for other materials shown were plotted on the curve by counting rate only; their effective atomic numbers are obtained from the indicated points on the abscissa. The significance of a material's effective atomic

number lies in the fact that this is an independent variable and is a characteristic of the material itself, whereas the counting rate is a dependent variable and is fixed not only by the material but also by the properties of the gage. Analysis of the data on the curve indicates that with the Michigan gage the counting rate varies as  $Z^{1.037}$  between cork and Al, as  $Z^{1.115}$  between Al and Cu, as  $Z^{1.447}$  between Cu and Ag, and as  $Z^{1.775}$  between Ag and Pb. Figure 12 shows the relationship between counting rate and specific gravity for the same materials. Noteworthy is the tendency for common engineering materials to cluster in "family groups" on these curves, a tendency which could undoubtedly be made to form the basis for an analytical or identification procedure for some materials.

#### Principle of the Beta Gage:

For a stipulated source, geometry and counter assembly, the beta ray backscatter counting rate at infinite thickness is a characteristic property of any given material. It makes no difference what is behind or beyond the material, because those beta rays possessing sufficient energy to pass completely through the material and become affected by what lies beyond will not have enough energy to return and leave the surface of the material at which they entered it. Those which do not traverse the material completely are unaffected by what lies beyond.

If, however, the material whose backscatter counting rate is being measured is of less than its infinite thickness, then what is behind or beyond the material becomes of significance. The significance lies in a change of counting rate, and this fact affords the key to the use of the beta gage for determining the thicknesses of materials.

For example, it was found with the Michigan gage that the material "tempered masonite" yields a net backscatter counting rate of 12.85 c/s at infinite thickness. One may assume, for example, that a certain pavement

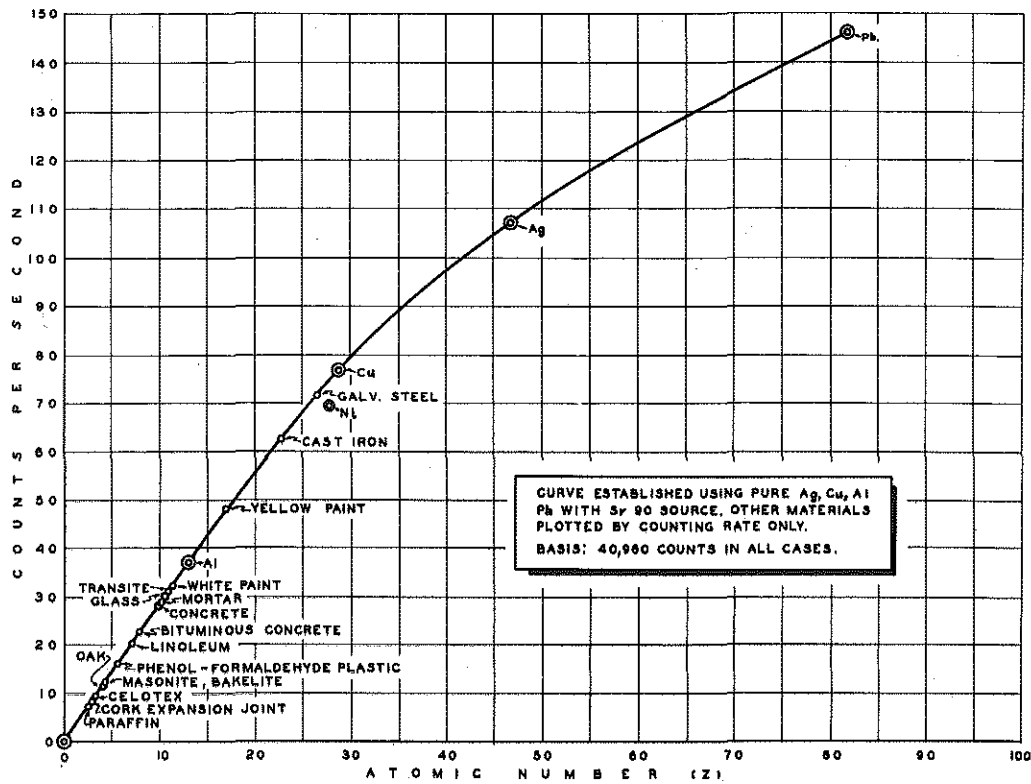


FIGURE 9

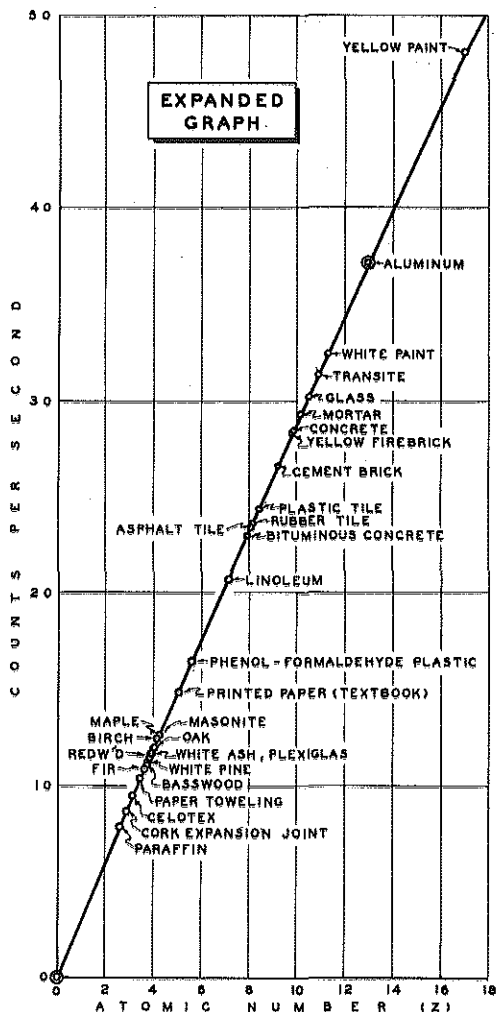


FIGURE 10

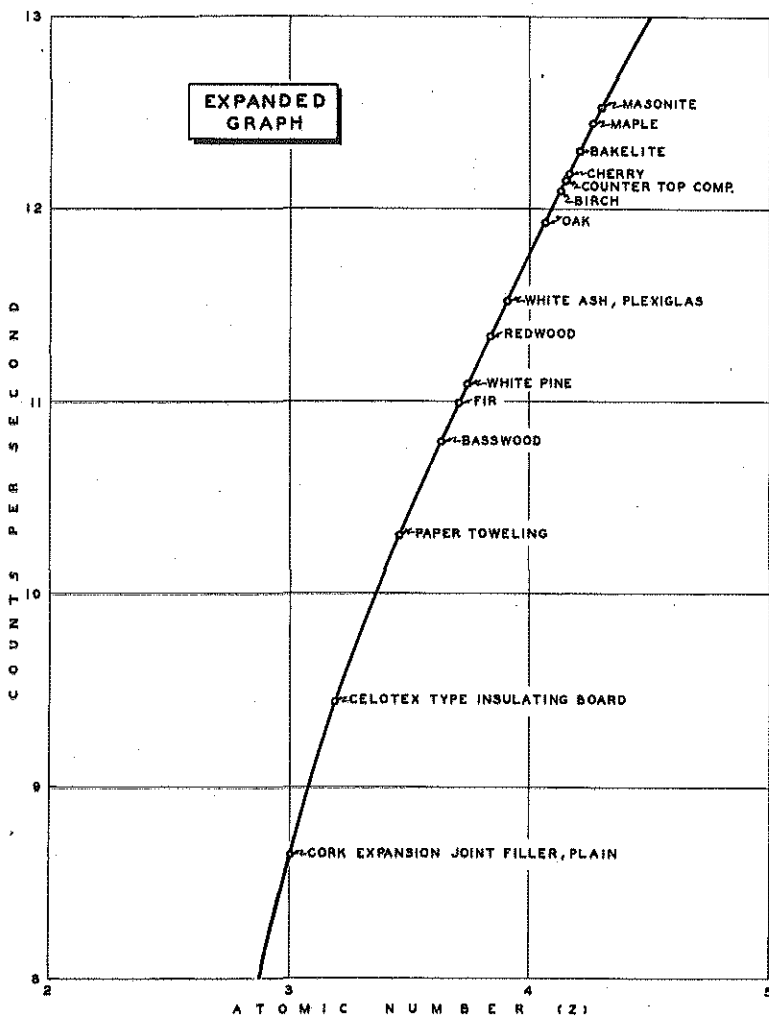


FIGURE 11

BACKSCATTER COUNTING RATE AS A FUNCTION OF EFFECTIVE ATOMIC NUMBER FOR INFINITE THICKNESSES OF MATERIALS SHOWN

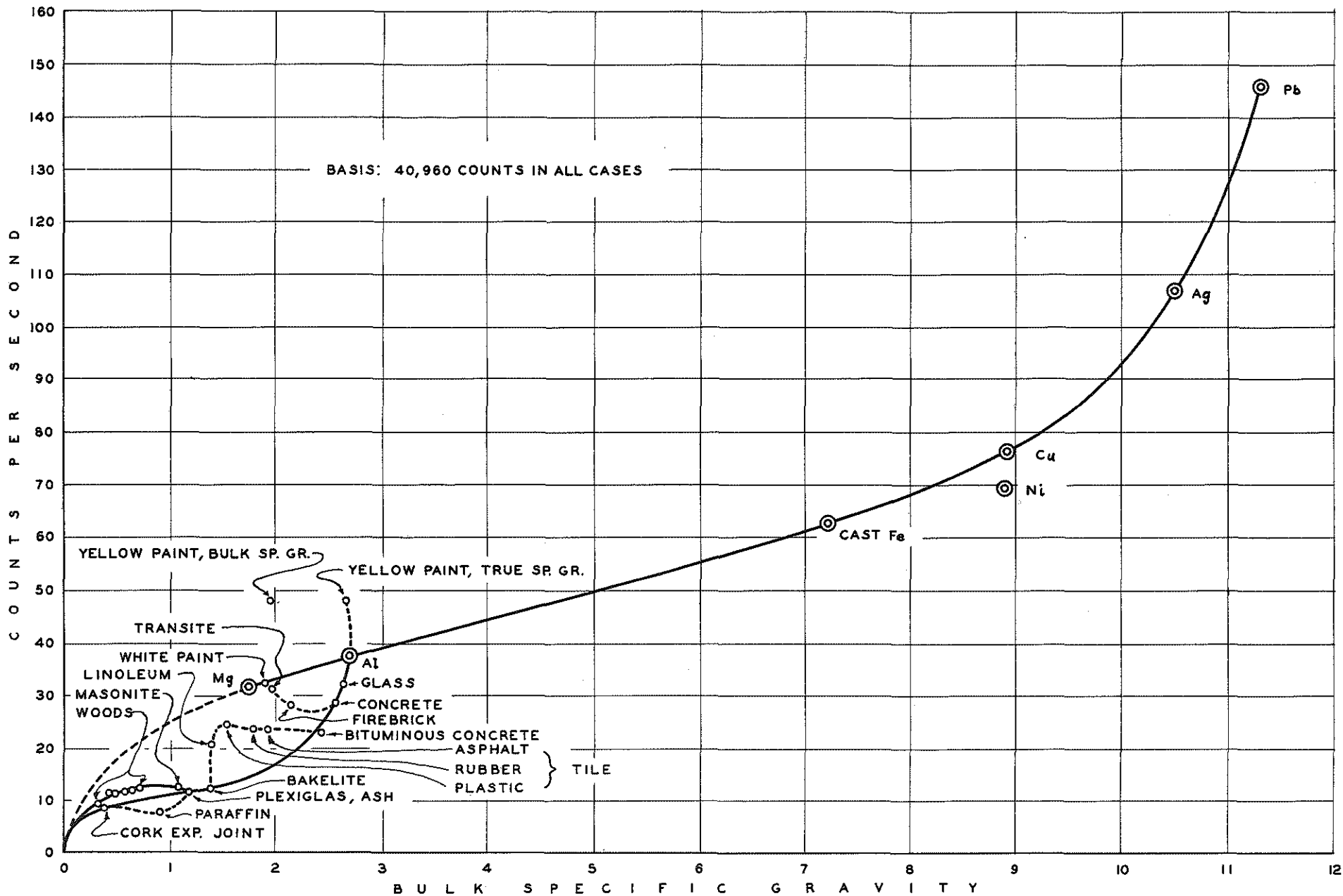


FIGURE 12  
 VARIOUS ENGINEERING MATERIALS  
 COUNTING RATE VS. SPECIFIC GRAVITY

marking paint when applied over any convenient material as a thick coat and allowed to dry (after which it is of infinite thickness or greater) yields a net backscatter counting rate of 32.67 c/s. If one applies a very thin but uniform coat of this paint over tempered masonite the resulting counting rate will be slightly more than 12.85 c/s. Thicker coats will result in higher rates until the rate of 32.67 c/s is attained. The thickness at which 32.67 c/s is just reached is the minimum infinite thickness value for that paint.

Conversely, it was determined that a galvanized steel panel will yield a net count of 72.71 c/s with the Michigan gage. A light coat of the same paint will lower the rate somewhat. Heavier coats will reduce the rate more and more until again the rate of 32.67 c/s is reached. At the point where it is just reached the paint is again of minimum infinite thickness, the same thickness as above.

#### Application to Traffic Paints:

It was shown at the outset that the infinite thickness backscatter counting rates for the traffic paints under investigation were not the same. They varied in fact from a low of 26.88 c/s to a high of 57.36 c/s; the yellow paints generally having higher rates than the white paints. Inasmuch as the rate at infinite thickness of portland cement mortar was determined to be 29.50 c/s, it was felt desirable initially to employ a supporting ring of a material other than mortar, preferably one having a counting rate at infinite thickness as different as possible from those of the paints, from a practical standpoint. This was for the purpose of obtaining maximum precision in establishing calibration curves for laboratory thickness determinations, at the same time using a supporting medium which would be satisfactorily inert to wear tests. Commercial tempered masonite gave promise of fulfilling these requirements.

At the time of this study the laboratory was engaged in an investigation of 18 traffic paints. Nine of these were white and nine were yellow. It was decided to use a new masonite ring for each wear test, and to apply a total of 18 stripes evenly spaced with duplicates opposite each other. In this way it would be possible to avoid having whites and yellows on the same ring with the accompanying danger of transferring pigments. Paints were applied by doctor blade in the "as received" condition. None of the paints contained beads.

#### Calibration of the Beta Gage:

Before attempting to make use of the gage for the purpose of following changes in thickness of paint films brought about during the course of laboratory abrasion tests, it was necessary to construct calibration curves of counting rate vs. thickness for the paints under consideration. The following procedure was adopted for establishing these curves.

Several panels were prepared of tempered masonite, measuring 3 x 6 x 1/4 inches. These were numbered on the backs, touched up along the edges with fine garnet paper, wiped free of all loose material, weighed, and the tare weights recorded. Ten such panels were assigned to a given paint. Typically, the panels comprising a group were given a light spray coat of the appropriate paint. Every effort was made to spray the paint as uniformly as possible over the entire panel, although the total amount of paint varied from panel to panel. The edges of the panels were masked off in all cases and the tape was not removed until the panels were dry. The panels were stored horizontally, face up, on shelves in a dustproof cabinet for approximately two weeks, by which time they had reached relatively constant weight. Backscatter counting rates were then obtained, after which the panels were weighed again and the weights recorded. This procedure was repeated with second, third, fourth and fifth coats; occasionally a sixth coat was included.



When it was felt that sufficient data had been procured to establish a calibration curve of counting rate vs. thickness, to thicknesses well in excess of 15 mils, that panel having the most uniform appearance was selected and broken for accurate measurement of film depth.

Breaking of panels was accomplished by heavy impact of the back of the panel against a firm, straight, sharp 90-degree steel edge, which caused the panel to break with the paint film in instantaneous tension, the break running as straight as possible across the diameter of the circle of backscatter. One of the edges of the broken film was then held upright and its thickness determined under a microscope equipped with a calibrated scale reading in thousandths of an inch. Readings were estimated to the nearest tenth of a mil. The average of at least ten readings taken at equal increments across the effective diameter of backscatter measurement was accepted as the true thickness of the paint film on the panel.

A factor was obtained by dividing the optically-determined thickness in mils by the weight of the film in grams. This factor was applied to all weights recorded for the given paint for the purpose of converting weights to thicknesses. Thus in this manner it became possible to plot final curves of counting rate against thickness for the paints under investigation.

As these calibration curves were obtained, it became apparent that they tended to follow a definite pattern. Regardless of the fact that individual counting rates at infinite thickness were all different, all the curves tended to have the same shape, as shown in Figure 13. Moreover, it was found that at any thickness, the ratio of counting rate at that thickness to the counting rate at infinite thickness for the same paint was approximately the same for all paints, provided the counting rate for tempered masonite alone was subtracted before calculating the ratio. After 16 of the 18 calibration curves had been plotted, the constancy of this ratio had become so apparent that it was decided not to complete the work of estab-

lishing calibration curves for the remaining two paints, but rather to construct these curves empirically. It was proposed after this had been done to prepare a panel with each of the two paints, run backscatter counts, break the panels, and compare optically-determined thicknesses with thicknesses read from the empirically constructed calibration curves.

This procedure was carried out by reading directly, from the 16 calibration curves at increments of 1 mil thickness, the height of the curve above the base line (masonite counting rate at infinite thickness of masonite) and expressing that height as a percentage of the ultimate height (paint counting rate at infinite thickness of paint). All 16 percentages thus obtained from the different paints were averaged at each mil thickness of paint film. In this manner there were obtained out of a universe of 16 traffic paints a series of percentages which it was hoped would be useful in setting up calibration curves for other paints, even when applied over materials other than masonite, provided only that counting rates at infinite thickness of paint and supporting material be known. These percentages are listed in Table I.

Curves for the two remaining paints were constructed on the basis of these percentages. Experimental panels were prepared, cured, counted and broken. In the case of each paint, thickness determined from the empirical curve compared precisely with thickness measured under the microscope by other operators.

When plotted on logarithmic coordinate paper, the calibration curves resulted in straight lines, as shown in Figure 14. When extrapolated to values at infinite thickness, the points of intersection of these lines with the counting rates at infinite thickness gave an average thickness value of approximately 26 mils as mean minimum thickness at infinite thickness for 18 paints.

All determinations of backscatter counting rates of paints at infinite thickness were conducted using specimens prepared by pouring layers of paint which dried to a minimum thickness of one-eighth inch. Each determination was based on 256,000 counts, with corresponding statistical accuracy of plus or minus 0.198 per cent. Rates of specimens of less than infinite thickness used in establishing the calibration curves were based on 25,600 counts for each determination, with statistical accuracy of plus or minus 0.625 per cent. Inaccuracies other than statistical include errors caused by the difficulty of spraying successive coats of paint uniformly, uncertainties introduced by the curing periods employed, and nearly negligible effects due to slight deterioration of the source within the duration of the research. Any tendency for the gage to sink into a thick layer of paint (or other coating) and thereby reduce the scatterer-to-source-tube distance is minimized by the design. Only the weight of the counter tube, plastic supporting tubes, rings, and the source holder rests directly on the paint film. This slight pressure is largely offset by provision of an extra bearing surface for contact with the paint, in the form of a 1/2-inch band of plastic measuring 2-1/4 inch OD and 1-3/4 inch ID. The latter dimension establishes the circle of backscatter count, or effective aperture of the instrument.

As shown in Figure 15, the calibration curves may also be plotted in accordance with the general activity formula,

$$\frac{A_i - A_x}{A_i} = e^{-kx}$$

where  $A_i$  = Activity at infinite thickness (100%)  
 $A_x$  = Activity at thickness x in per cent  
 $k$  = Composite backscatter factor  
 $x$  = Thickness

In this plot, thicknesses are in mils, not in  $\text{mg}/\text{cm}^2$ , thus accounting for the wide differences among paints, since densities are ignored. Values of  $k$  are

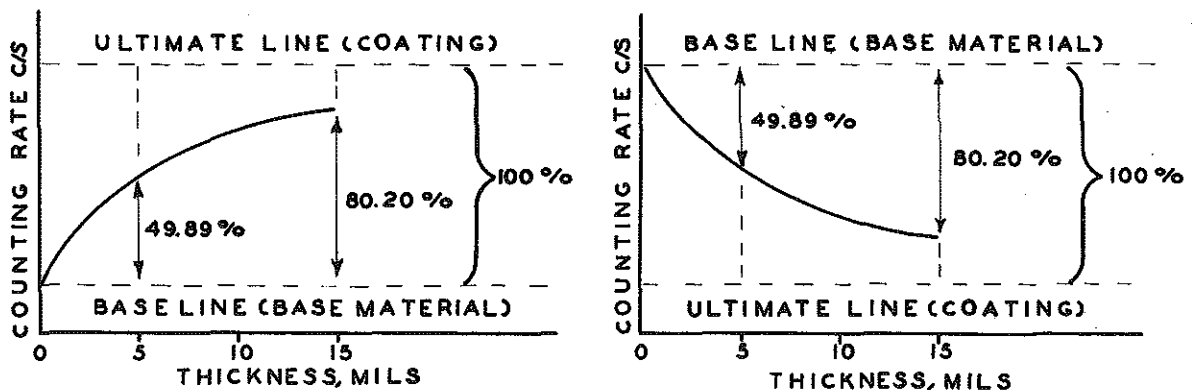
TABLE I - PERCENTAGES FOR CONSTRUCTING EMPIRICAL CALIBRATION CURVES

Thickness, mils	Percentage	ASTM Dispersions ( n = 16 )		
		Standard Deviation, $\sigma$ , Per cent	Coefficient of Variation, $\frac{V}{\bar{V}}$ , Per cent	Nine-tenths Error, Plus or Minus, $0.453 \times \sigma$
1	17.55	3.55	20.20	1.61
2	28.71	3.59	12.50	1.63
3	37.49	4.04	10.79	1.83
4	44.22	4.32	9.76	1.96
5	49.89	4.30	8.62	1.95
6	54.71	4.39	8.00	1.99
7	58.90	4.43	7.52	2.01
8	62.59	4.40	7.04	1.99
9	65.94	4.45	6.74	2.02
10	68.90	4.35	6.31	1.97
11	71.61	4.24	5.92	1.92
12	74.04	4.32	5.83	1.96
13	76.31	4.12	5.40	1.87
14	78.33	4.12	5.26	1.87
15	80.20	4.00	4.99	1.81

Explanation:

If at the stated thicknesses the difference is considered between the counting rate at infinite thickness of the uncoated base material (base line) and the counting rate at infinite thickness of the coating material (ultimate line), the above are the percentages at the stated thicknesses of coating material which the distances from base line to curve are of the total distance from base line to ultimate line.

Example:



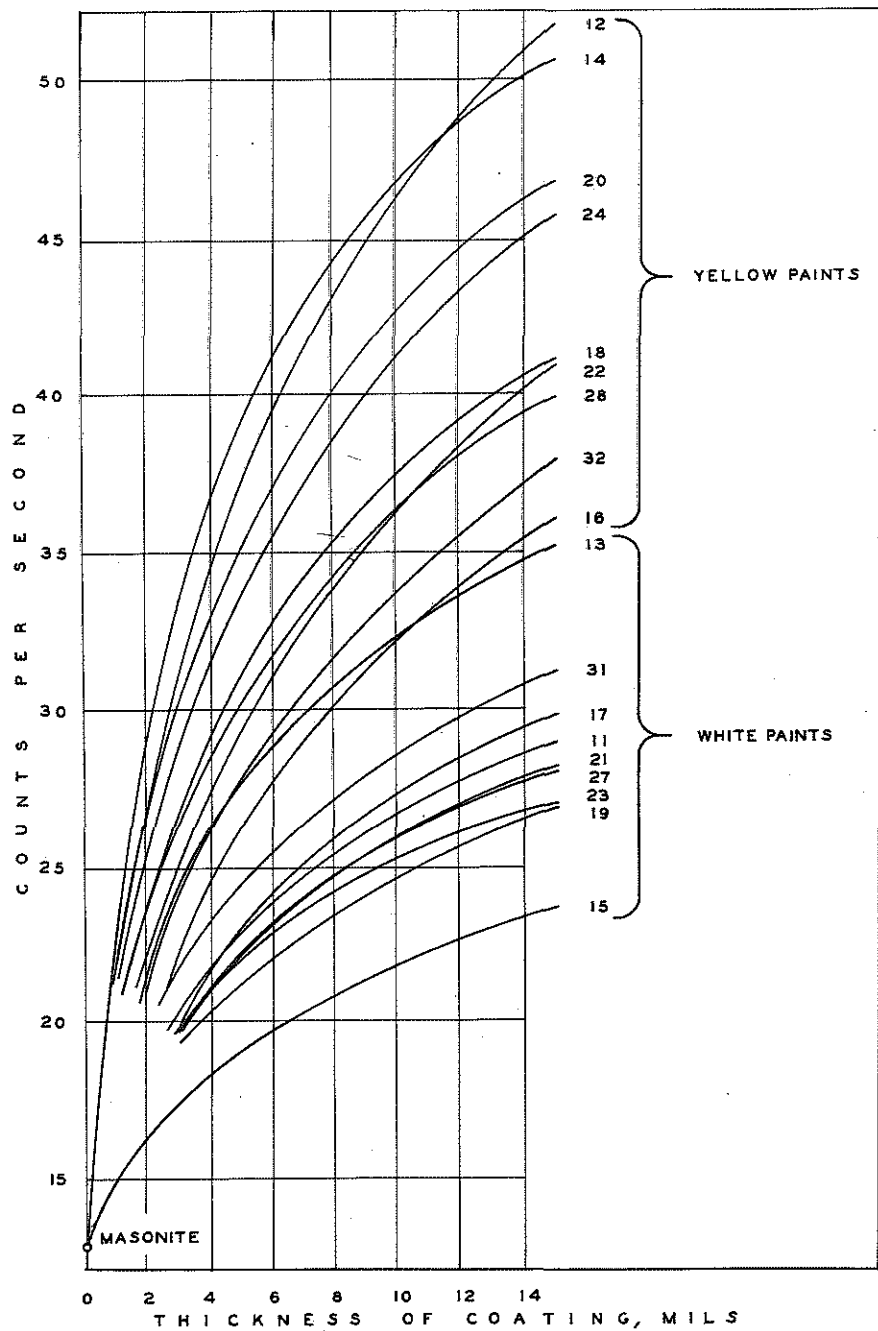


FIGURE 13  
TRAFFIC PAINTS OVER MASONITE  
COUNTING RATE VS. THICKNESS

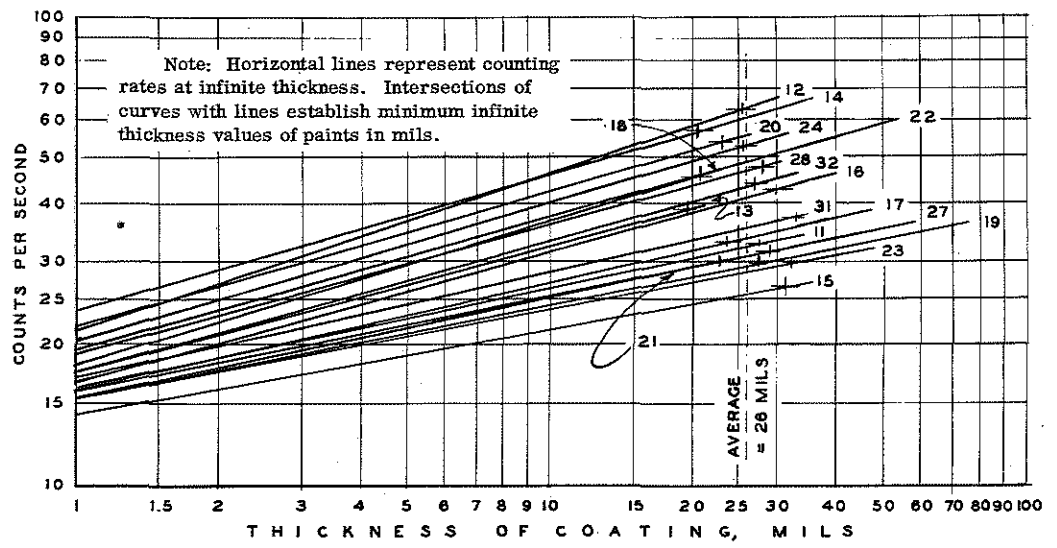


FIGURE 14.  
TRAFFIC PAINTS OVER MASONITE,  
COUNTING RATE VS. THICKNESS

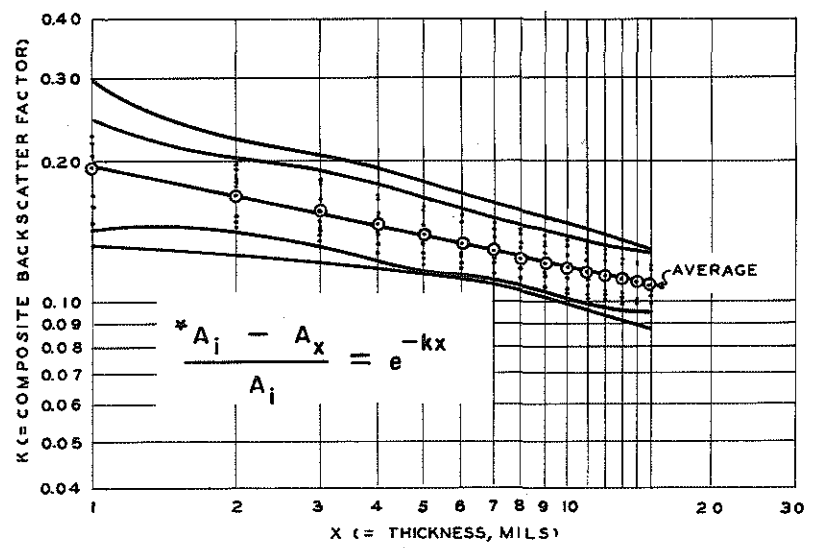


FIGURE 15.  
GRAPH OF k VS. x IN GENERAL ACTIVITY FORMULA \*  
FOR TRAFFIC PAINTS STUDIED

plotted against values of x on logarithmic coordinate paper. It is noteworthy that although curves for individual paints deviate from linearity, that representing the average of all the paints is practically straight.

#### Calibration Curves for Field Use:

Figures 16 and 17 are calibration curves for the same paints on bituminous concrete and portland cement concrete respectively. These curves were constructed empirically by use of the percentages listed in Table I.

### RESULTS USING RADIOACTIVITY

Once calibration curves of backscatter counting rate vs. thickness had been established for 9 white and 9 yellow traffic paints, the laboratory was in a position to use these for evaluating results of wear tests, as shown in Figure 18. Figure 19 shows the results of the wear tests on white paints appraised by the beta ray backscatter technique. Each point on this graph represents the average thickness of two paint stripes. Curing time prior to abrasion was three weeks at room temperature.

Original dry film thicknesses for the 9 white paints varied from 5-1/4 mils to 10-1/2 mils. Obviously it would be difficult to appraise traffic paint wear by means of a grid on the assumption that all stripes started out at the same thickness, when actually some were twice as thick as others to begin with. This finding was confirmed and extended in a corresponding wear test on the 9 yellow traffic paints, the results of which are shown in Figure 20. Original stripe thicknesses ranged from 4 to 19 mils. The author recognizes that laboratory and field tests based on stripes applied without consideration of differences in original dry film thickness can be evaluated by taking account of cost factors and by

COUNTING RATE VS. THICKNESS

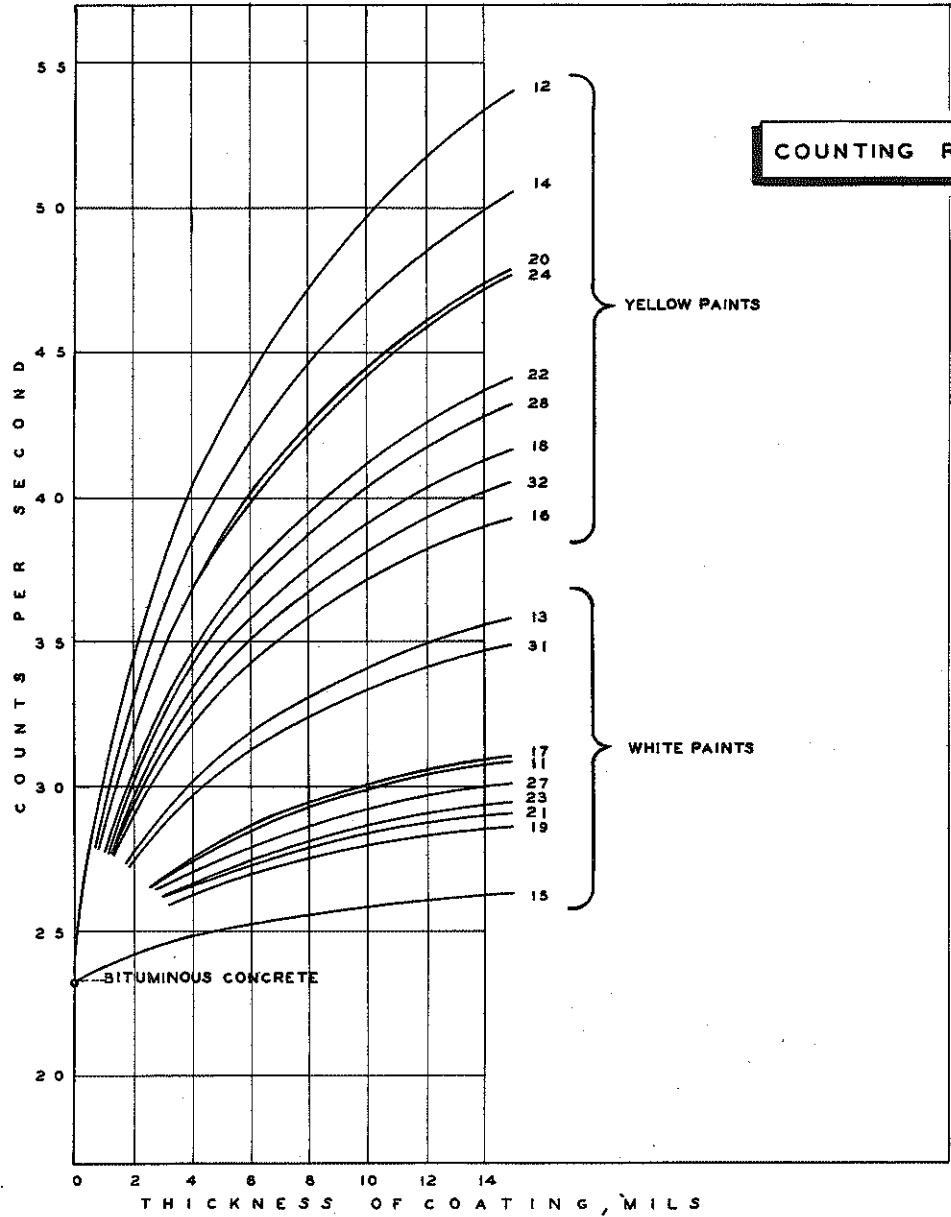


FIGURE 16.  
TRAFFIC PAINTS OVER BITUMINOUS CONCRETE

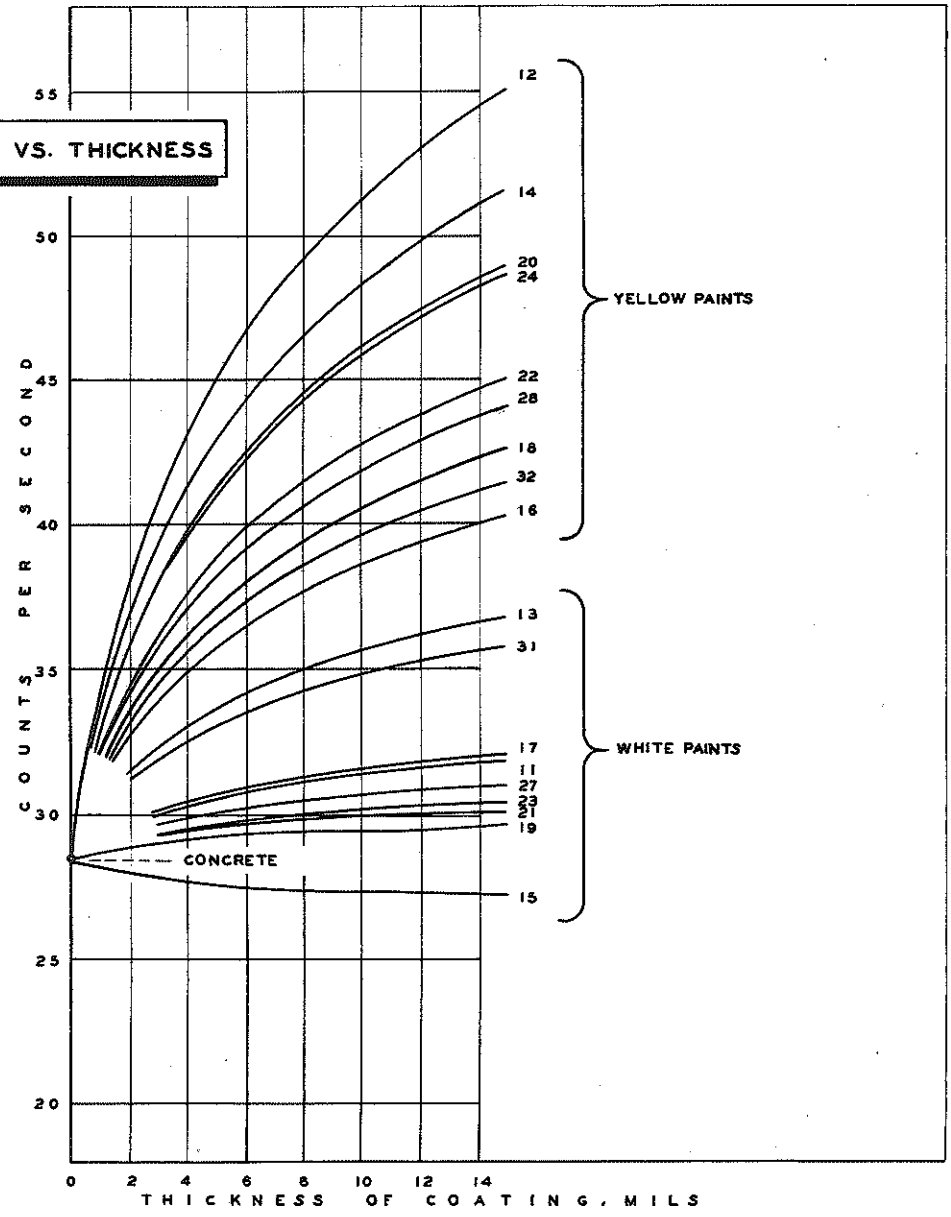


FIGURE 17.  
TRAFFIC PAINTS OVER PORTLAND CEMENT CONCRETE



throwing the burden of proof upon the manufacturers' recommended methods of application, but such evaluations fail to elicit fundamental technical information.

With the exception of paints No. 11 and No. 27, all of the white paints followed the same general pattern of wear. Paint No. 11 appeared to be outstanding in its resistance to the type of abrasion employed. Paint No. 27 followed the general overall wear pattern, but its reduction in film thickness was irregular. This paint was the only one applied in two coats, with 24-hour drying between coats. The mode of its application is apparent in the wear curve, which indicates a definite increase in wear resistance as the relatively cured (and therefore harder) surface of the first coat became exposed.

#### FUTURE APPLICATIONS

The apparatus employed by the Michigan State Highway Department for beta ray backscatter measurement of paint film thickness was developed with a view toward portability. The gage was designed so that it could be used in the field, with portable or mobile generator, and with pre-amplifier to compensate for longer lead to the scaler. (No pre-amplifier was used in the applications here reported.) Whether or not pavement surfaces will prove to be sufficiently plane and homogeneous statistically for acceptable measurements to be made is still to be determined. Also, calibration curves for paints containing beads have not been established. However, the possibilities inherent in applicability of the method to field measurements appear hopeful.

Furthermore, actual abrasion resistance is only one of the several factors responsible for the durability of traffic paint. It is to be hoped that the beta ray backscatter gage will be useful in studies of chipping

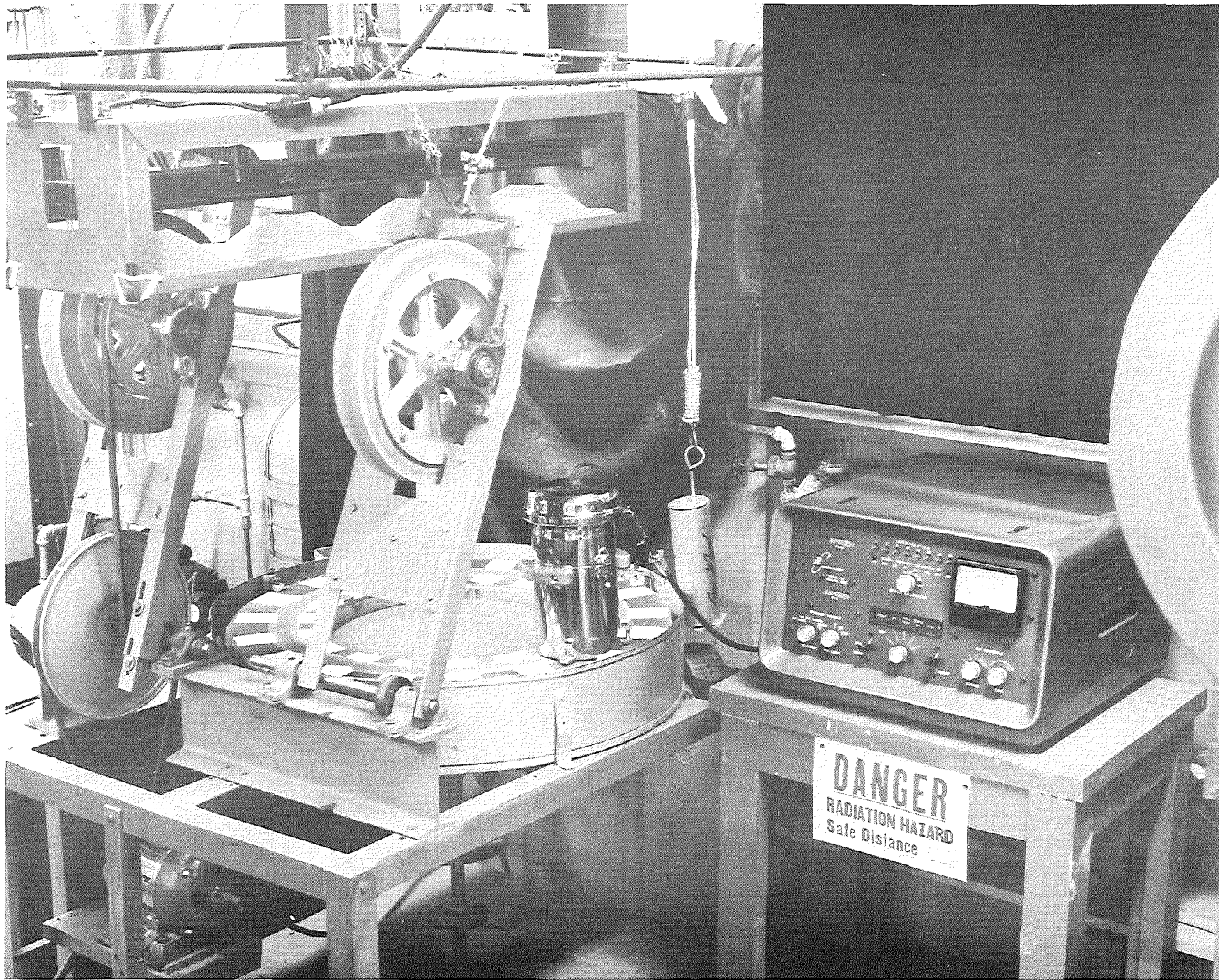


FIGURE 18  
BETA GAGE IN USE FOR DETERMINATION  
OF PAINT FILM THICKNESSES

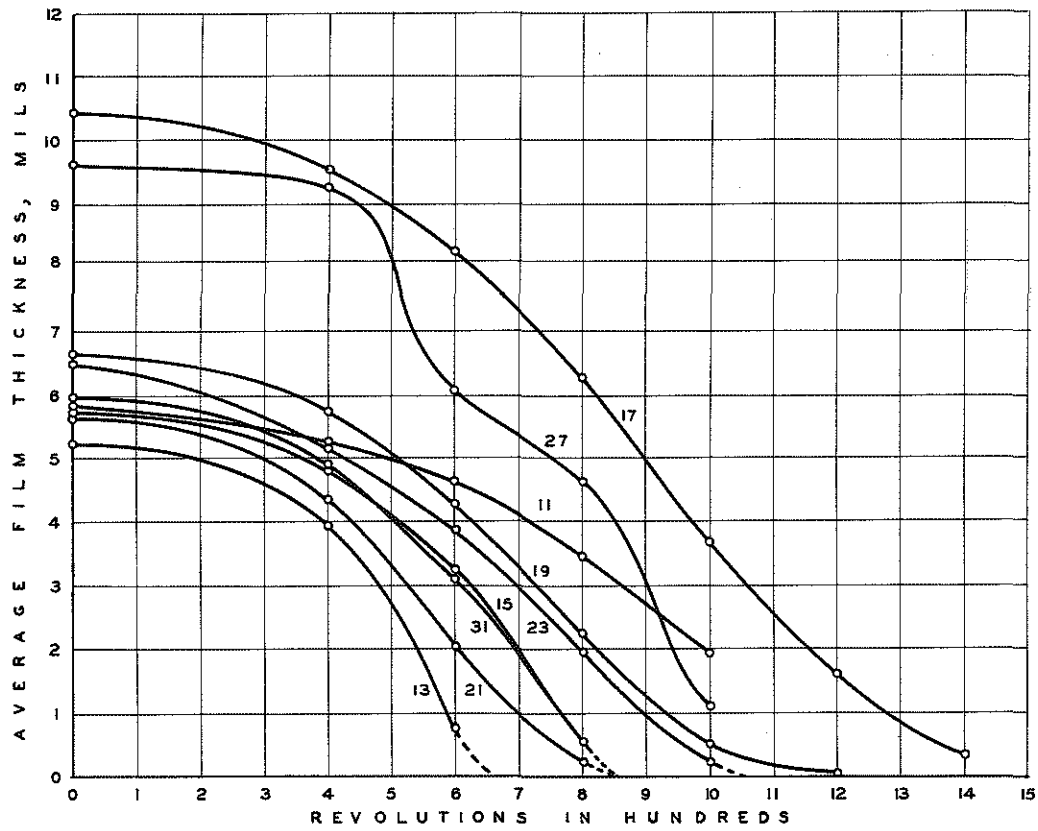
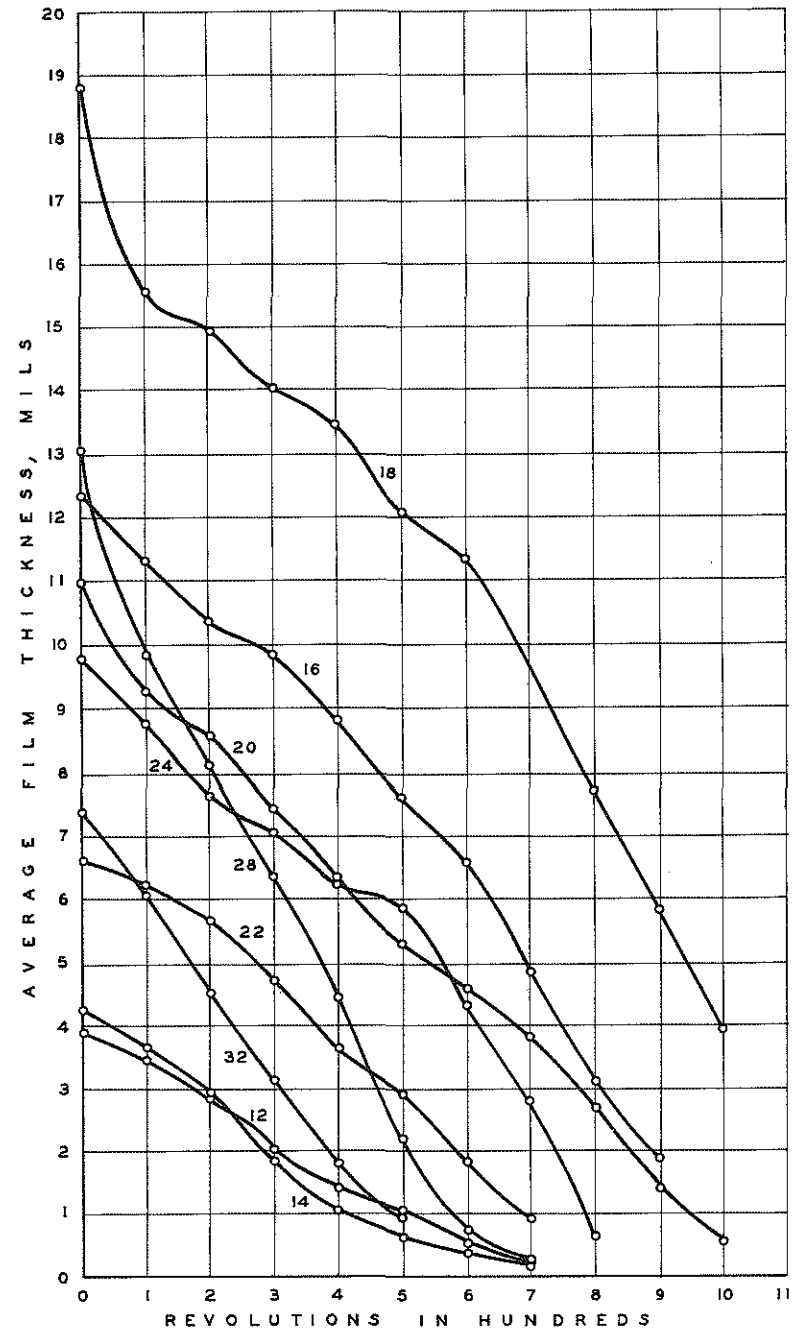


FIGURE 19  
WHITE PAINTS

ABRASION RESISTANCES  
OF TRAFFIC PAINTS

FIGURE 20  
YELLOW PAINTS



from pavement surfaces, of the effects of dew, of solvents, of freezing and thawing cycles, and of other factors not yet completely investigated as independent variables.

## CONCLUSIONS

Results of this research indicate that:

1. The beta ray backscatter gage is a useful instrument with which to follow changes in paint film thickness produced by laboratory abrasion tests. Dry film thicknesses can be determined to the nearest tenth of a mil, provided infinite thickness counting rates of paint and supporting medium be sufficiently different.

2. Calibration curves of counting rate vs. thickness can be plotted empirically for any coating on any supporting medium provided only that the following conditions be fulfilled: (1) that the coating and its support have different effective atomic numbers, and (2) that the beta ray backscatter counting rate at infinite thickness for both materials be known.

3. The average minimum infinite thickness of 18 traffic paints investigated was 26 mils, using the Michigan gage charged with Sr 90.

4. Common engineering materials tend to form generic groupings when arranged by beta ray backscatter counting rates according to effective atomic numbers. Those of similar bulk specific gravities tend to form generic groupings when arranged according to beta ray backscatter counting rates.

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